NAMIBIA

A. Regulation on sources

Source of lead	Relevant legislation/regulation	Government agencies	Data source
	No standards found at this time for lead.		

B. International Agreements

Agreement	Year Ratified
1. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	1995 (a)[1]
2. Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade	2005
3. Minamata Convention on Mercury	2017 (a)
4. Stockholm Convention on Persistent Organic Pollutants	2005 (a)

C. Blood lead-level monitoring programs

Details	Data source
1. No details of a national or regional level structured program for blood lead level testing found.	

[1] Accession (a)

D. Inventory of toxic sites (Toxic Sites Identification Program (TSIP), Pure Earth)

No toxic sites yet identified at this time.

E. Scientific papers on lead exposure (Please contact info@gahp.net for information on studies not in the public domain)

Topic	Authors	Year	Title	Abstract/ description
Lead contamination	Fry, K; Taylor, M; Flegal, A; Mclennan, M; Wheeler, C	2019	Contamination of soil and dust with arsenic, copper and lead from smelting operations in Namibia: implications for human health exposures	**Abstract:** Contamination of soil by smelter emissions is well documented, yet the role of dust as a contamination medium and its impact on human health is often overlooked. We examined the relationship between Cu smelter emissions, environmental contamination and human health implications in Tsumeb, Namibia (pop. ~20,000), with a focus on human health risk from As, Cu and Pb dust exposure. Mining and smelting of Cu and Pb at Tsumeb has been ongoing since 1905. Most research has focused on the geochemical composition of emissions and deposition in the rural area away from the city, with limited work to evaluate the potential risk to the city population. Soils and dusts were sampled in July 2018 across Tsumeb city (~ 400 m grid) to determine the dispersal of the smelter-related contaminants of concern: As, Cu, Pb. Soils concentrations were measured in-situ using portable X-ray fluorescence spectrometers (pXRF) (n = 84). Deposited dusts were collected using surface wipes (n = 80) at co-located sites and analysed using pXRF in the field. A subset of wipes (n = 23) was also analysed by ICP-MS for pXRF calibration; linear regression modelling was used to correct in-field pXRF measures. Health risk assessment was undertaken using standard US EPA methods to calculate potential carcinogenic and non-carcinogenic exposure risks to As, Cu and Pb in soil and dust for children and adults. Soil contaminant concentrations were below US EPA levels of concern and did not present a health risk in adults or children. By contrast, mean dust wipe values were significantly elevated (As = 1012 µg/m2 (95% CI 687-1337); Cu = 1838 µg/m2 (95% CI 1191-2485); Pb = 1624 µg/m2 (95% CI 862 - 2385) with As and Cu values exceeding the US EPA carcinogenic risk threshold for adults and children.

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				Ingestion exposures were identified as the greatest concern, followed by inhalation. Dermal contact with the trace contaminants in dust poses a carcinogenic risk for children. Assessment of Pb isotopic compositions (PbIC) in dust, the exposure source of most concern, showed that 74% of the wipes analysed (n=17/23) corresponded to the PbICs of smelter's slags and tailings, linking current exposure risk to ongoing industrial emissions. Contemporary smelter operations are associated with ongoing potential health risks to both children and adults. Further work is required to mitigate emissions.
	Mihaljevic, Martin; Voljtech, Ettler; Vanek, Ales; Chrastny, Vladislav; Kribek, Bohdan; Penziek, Vit; Sracek, Ondrej	2013	Copper and lead isotopic and metallic pollution record in soils from the Kombat mining area, Namibia	**Abstract:** Copper (Cu) and lead (Pb) concentration, isotopic composition (206Pb/207Pb, 65Cu/63Cu) and speciation were studied in soils from the Kombat mining area. The Cu and Pb concentrations in the studied soils ranged between 21 mg/kg - 757 mg/kg, and 19 mg/kg - 815 mg/kg respectively. In the sequential extractions, the largest part of soil Cu appeared in the residual and reducible fractions and Pb was predominantly bound in reducible and residual fractions and was more mobile compared to Cu. Copper and Pb concentration are higher in soils close to the slime deposit. Concentration of both metals increased with increasing soil depth in irrigated and cultivated soils. In soils not contaminated by dust eroded from the slime deposit, Cu and Pb contents are not dependent on the soil depth. The Pb isotopic signatures (206Pb/207Pb) ranged between 1.15 - 1.21 in soils from the Kombat area. In most of soil samples, surface horizons exhibited lower 206Pb/207Pb ratio, which originates from the slime dust pollution (206Pb/207Pb ~ 1.15) compared to deeper soil horizons, with lithogenic Pb signatures (206Pb/207Pb > 1.2). Isotopic composition of Cu differs on contaminated and uncontaminated sites and cultivated and non-cultivated sites. The δ65Cu in the studied soil horizon ranged between -0.373 ‰ and 0.561 ‰. The most pronounced variations occurred in contaminated non cultivated and non-irrigated soils (0.529 ‰). The contaminated top horizons are enriched in isotopically heavier Cu (tailing materials), and δ65Cu decreased with depth. Irrigated (cultivated) and contaminated soils exhibited heavier Cu in the surface horizons (originated from tailing dust δ65Cu = 0.260), decrease of δ65Cu in Bt horizons (biological uptake of light isotope by crop, and their incorporation in this horizons) and increase of δ65Cu in Bc horizons. The Bc horizons of

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				cultivated and irrigated Phaeozems are enriched in Mn nodules (0.2 - 1.5 cm diameter, prevailing Mn phase pyrochroite Mn(OH)2) which contain 400 mg/kg of Cu. Manganese nodules containing horizons are enriched in isotopically heavier Cu (δ65Cu = 0.378 ‰). Similar δ65Cu patterns were found in soils without manganese nodules, but with higher secondary iron and aluminium hydroxides, which may bound Cu on their surfaces. Fractionation of Cu isotopes (enrichment in 65Cu) in soil formation processes are attributed to preferential adsorption of heavier isotopes on secondary soil components.
Lead deposits	Frimmel Hatwig; Jonasson, Ian; Mubita, Petronella	2004	An Eburnean base metal source for sediment-hosted zinc-lead deposits in Neoproterozoic units of Namibia: Lead isotopic and geochemical evidence	**Abstract:** The lead isotopic composition of galena from the Neoproterozoic sediment-hosted Zn-Pb sulphide deposit at Rosh Pinah and the oxidised Zn deposit at Skorpion in the Pan-African Gariep Belt, southwestern Namibia, as well as that of galena from minor occurrences in the wider Rosh Pinah ore province was investigated and is compared with that of other major sediment-hosted base metal ore deposits hosted by Neoproterozoic strata in southwestern Africa and Brazil. The isotope data were supplemented by a geo-chemical provenance study of the argillitic host rock to the Rosh Pinah deposit and its stratigraphic equivalents. The pre-orogenic Rosh Pinah deposit and the inferred progenitor for the secondary Skorpion deposits have very similar Pb isotopic compositions. In contrast, syn-orogenic deposits (e.g., Tsumeb-type) show a larger proportion of radiogenic Pb from the country rocks that were infiltrated by orogenic ore fluids. In all examples studied, the ore Pb has elevated207Pb/204Pb ratios compared to Pb that evolved according to average crustal Pb growth models. The isotopic composition of the ore Pb is in agreement with that of the oldest crustal component known from the pre-Gariep basement, i.e.an Eburnean (c. 2.0 Ga) volcanic arc, best preserved in the Richtersveld Terrane, that represents the largest volume of post-Archaean juvenile crust in southern Africa. Erosion of that arc provided the main sediment source for the metasedimentary siliciclastic host to the Rosh Pinah deposit. Derivation of the Pb, and by analogy Zn, from this Eburnean volcanic arc is therefore inferred for the formation of Rosh Pinah-type synrift, early diagenetic replacement mineralisation. The calculatedl2- andx2-values for the Rosh Pinahore province (around 10.2 and 42, respectively) are higher than predicted by

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				conventional Pb crustal growth models and are similar to those found in the wider region of southern Africa (Otavi Mountain Land) and eastern Brazil. The obtained data highlight not only that calculated Pb model ages may have no geochronological significance but might also point to a common crustal evolution of this part of SW-Gondwana.
Lead in animals	Burger, Joanna; Gochfeld, Michael	2001	Metal Levels in Feathers of Cormorants, Flamingos and Gulls from the Coast of Namibia in Southern Africa	**Abstract:** Arsenic, cadmium, chromium, lead, manganese, mercury, selemium, and tin concentrations were measured in the feathers of Capecormorant (Phalacrocorax capensis), Hartlaub's gull(Larus hartlaubii), kelp gull (Larus dominicanus), andlesser flamingo (Phoeniconaias minor) from the coast ofNamibia in southern Africa. Metal concentrations in feathers represent the concentrations in the blood supply at the time offeather formation. Cape Cormorants are piscivores; kelp gullsare primarily piscivores; Hartlaub's gull is an omnivore; and lesser flamingos eat primarily blue-green algae and invertebrates filtered from the water and sediment ofhypersaline lagoons. We predicted that metal concentrationswould reflect these trophic level differences. There weresignificant species differences in the concentrations of allmetals, with flamingos having the lowest levels, and cormorantshaving the highest levels of 4 metals but not mercury. The gulls hadthe highest levels of mercury, perhaps reflecting their more scavenging behavior.
Lead in food	Madzingira, O; Lifumbela, LZ; Kandiwa, E; Kandjengo, L; Mushonga, B	2020	Cadmium and lead levels in three freshwater fish species from the Zambezi region, Namibia	**Abstract:** Muscle tissue from three-spotted tilapia (Oreochromis andersonii) (n = 11), sharp tooth catfish (Clarias gariepinus) (n = 14) and tigerfish (Hydrocynus vittatus) (n = 12) were sampled from a market in the Zambezi region, Namibia in June 2018 and analysed for cadmium and lead. Cadmium was not detected in the three fish species. Mean lead levels in all three fish species (0.09–0.19 mg kg−1) were below the recommended safe level of 0.3 mg kg−1. Catfish had the highest mean lead concentrations, followed by tigerfish and tilapia in descending order. However, the differences in mean lead concentrations between the three fish species were not statistically significant (ANOVA, p = 0.18). These results show that the fish tested were safe for human consumption with respect to the metals tested. It is recommended that more metals and other contaminants, such as pesticides, be monitored robustly in water, sediment and fish, using the recommended protocols, in order to generate

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				data that can be reliably used for human health risk assessments in the future.
	Midzi, Emmanuel	2012	Cadmium and lead concentrations in livers and kidneys of cattle slaughtered at Grootfontein abattoir in Namibia	**Abstract:** The aim of this study was to determine the levels of cadmium (Cd) and lead (Pb) in livers and kidneys of cattle slaughtered at Grootfontein abattoir in Namibia. The study design was based on the epidemiological principles to detect a single animal whose kidneys or liver contained Cd or Pb residues. The Grootfontein area of Namibia has extensive base-metal ore reserves, which were and are still extracted and processed in localities used as livestock pastures. Namibia is also an arid country which predominantly uses borehole water for livestock and human consumption. These underground water bodies share the same space as base-metal ores. The anthropogenic activities in this area under the existing geological and hydrogeological circumstances offer opportunities for Cd and Pb to enter the food chain. Entry of Cd and Pb in the food chain leads to bioaccumulation in cattle kidneys and livers to concentrations above Codex Alimentarius Commission (CAC) standards, creating a possible public health risk. The CAC withdrew the maximum limit (ML) of 1mg kg-1 Cd in bovine kidneys and liver, but it has a provisional tolerable monthly intake (PTMI) of 0.025mg kg-1 human body weight. This CAC PTMI translates to a total exposure of 1.5mg Cd for a 60kg body weight person. The CAC ML for Pb in bovine offal is 0.5mg kg-1, while its provisional tolerable weekly intake (PTWI) of 0.025mg kg-1 human body weight is under review. This investigation intended to establish if Cd and Pb in the livers and kidneys of cattle slaughtered in the study area exceeded CAC human exposure limits. Liver and kidney specimens were collected from 31 randomly sampled mature cattle (estimated over five years old based on incisor teeth examined post slaughter). The specimens were analysed at a local mine laboratory, which was the only facility available and capable of performing the tests. They were digested using wet-ashing (the oxidation procedure). All liver digestates were analysed, while one kidney analyte was insufficient. Cd and Pb were measured using flame atomic absorption spectroscopy (FAAS). The detection limit (DL), which was the minimum metal concentration FAAS could measure was

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				0.2mg kg-1 for Cd and 1.1mg kg-1 for Pb. The laboratory could not refine the Pb DL which was more than twice the CAC ML.
Lead in human milk	Klein, Laura; Breakey, Alicia; Scelza, Brooke; Valeggia, Claudia; Jasienska, Grazyna; Hinde, Katie	2017	Concentrations of trace elements in human milk: Comparisons among women in Argentina, Namibia, Poland, and the United States	**Abstract:** Human milk contains essential micronutrients for growth and development during early life. Environmental pollutants, such as potentially toxic metals, can also be transferred to the infant through human milk. These elements have been well-studied but changing diets and environments and advances in laboratory technology require re-examining these elements in a variety of settings. The aim of this study was to characterize the concentrations of essential and toxic metals in human milk from four diverse populations. Human milk samples (n = 70) were collected in Argentina (n = 21), Namibia (n = 6), Poland (n = 23), and the United States (n = 20) using a standardized mid-feed collection procedure. Milk concentrations of calcium, zinc, iron, copper, manganese, lead, arsenic, and cadmium were determined using inductively coupled plasma mass spectrometry (ICP-MS). We used standard multiple linear regression models to evaluate differences among populations, while including infant age, infant sex, and maternal parity status (multiparous or primiparous) as covariates. Concentrations of all elements, except zinc, varied across populations after controlling for infant age, infant sex, and maternal parity. Calcium and magnesium showed more differences across populations than iron or copper. There were no significant differences among population in zinc concentrations. Mean concentrations of lead, but not arsenic, were low compared to recently published values from other populations. The concentrations of trace elements in human milk are variable among populations. Limitations due to small sample sizes and environmental contamination of some samples prevent us from drawing robust conclusions about the causes of these differences.
Lead in mines	Criddle, A; Keller, P; Stanley, C; Innes, J	2018	Damaraite, a new lead oxychloride mineral from the Kombat mine, Namibia (South West Africa)	Abstract: Damaraite, ideally 3PbO.PbCl2, is a new mineral which occurs with jacobsite, hausmannite, hematophanite, native copper, an unnamed Pb-Mo oxychloride, calcite, and baryte, in specimens from the Asis West section of the Kombat mine, Namibia (South West Africa). Damaraite is colourless and transparent with a white streak, and adamantine lustre. It is brittle with an irregular to subconchoidal fracture and a cleavage on (010). The mineral has a low reflectance, a weak bireflectance, barely

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				discernible reflectance pleochroism, from grey to slightly bluish grey in some sections, and is weakly anisotropic. Reflectance data in air and in oil are tabulated. It has a VHN50 of 148 (range 145–154) with a calculated Mohs hardness of 3. X-ray powder diffraction studies give the following parameters refined from the powder data: orthorhombic; space group Pma2, Pmam or P21 am; a 15.104(1), b 6.891(1), c 5.806 (1)Å; V is 604.3 (4)Å3 and Z = 3. D calc 7.84 g/cm3. The strongest six lines of the powder pattern are [d in Å (I) (hkl)]: 2.902 (10) (121,002); 2.766 (10) (510,221); 2.877 (9) (411); 3.164 (6) (401); 3.135 (6) (220); 1.747 (b) (313,721,531). The name is for the Damara sequence which hosts the Kombat deposit.
	Mileusnic, Marta; Mapani, Benjamin; Kamona, Akalemwa; Ruzicic, Stanko, Mapaure, Issac; Chimwamurombe, Percy	2014	Assessment of agricultural soil contamination by potentially toxic metals dispersed from improperly disposed tailings, Kombat mine, Namibia	**Abstract:** The Kombat tailings dam, surrounded by agricultural lands, has been exposed to water and wind erosion over a long period of time. The objectives of this research were: (1) to characterize the tailings and the surrounding agricultural soils with respect to the mineral and trace element composition; (2) to determine the degree of soil pollution using soil contamination indicators; (3) to assess the environmental risk of polluted agricultural soil; and (4) to identify dominant type (mechanical and/or chemical) and dominant agent (water and/or wind) of metal dispersion from the tailings. A sequential extraction procedure was used to determine binding mechanisms involved in the retention of metals in tailings and soils under the influence of tailings, which indicate the trace metals bioavailability, the threat to groundwater pollution, as well as the dominant type of dispersion. Among seven analysed elements, copper and lead showed significantly high concentrations in tailings, especially in dry season (up to 9086 mg/kg and 5589 mg/kg, respectively). As a consequence, adjacent arable soils have high concentrations of Cu and Pb (up to 150 mg/kg and 164 mg/kg, respectively). Enrichment factors for lead and copper reveal severe contamination, while geoaccumulation indices disclose moderate to strong contamination by both elements. The combined pollution index points out high contamination. The main binding phase for Cu and Pb is the reducible fraction (oxides, hydroxides, oxyhydroxides). Similar metal distributions in the sequential extraction fractions of tailings and soils support the assumption that wind and water disperse tailings predominantly by mechanical transport to the surrounding agricultural soil. Although agricultural soils are contaminated

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				with Pb and Cu, these metals are relatively strongly bound to the soils and are of medium risk for their mobilisation after The Risk Assessment Code (up to 20% for Cu and up to 36% for Pb). Though rehabilitation of tailings dam, as well as limitation of certain crop use on polluted agricultural land, is recommended.
	Cairncross, Bruce; Fraser, Allan	2012	The Rosh Pinah Lead-Zinc Mine, Namibia	**Abstract:** The Rosh Pinah mine is located in southern Namibia, 20 kilometers north of the Orange River border with South Africa, at the edge of the Namib Desert between Diamond Area No. 1 and the farms Namuskluft 88 and Spitzkop III. The mine is somewhat isolated, and in order to get to it, many hours need to be spent driving the roads in southern Namibia. The main access road branches off from the tarred road between Keetmanshoop and Lüderitz; from there the mine is 160 kilometers to the south. The town of Rosh Pinah lies along a major tourism route within the Ai-Ais Richtersveld Transfrontier Park (Warambwa and Mouton 2011). Employees of both the Rosh Pinah mine and the nearby Skorpion mine live in the town.
Lead in soil	Mihaljevic, Martin; Ettler, Vojtech; Vanek, Ales; Penizek, Vit; Svoboda, Miroslav; Kribek, Bohdan; Sracek, Ondra; Mapani, Benjamin; Kamona, Akalemwa	2015	Trace Elements and the Lead Isotopic Record in Marula (Sclerocarya birrea) Tree Rings and Soils Near the Tsumeb Smelter, Namibia	**Abstract:** The contents of As, Cu, Cd, Pb, Mn, along with the Pb isotopic ratios 206Pb/207Pb and 208Pb/206Pb were studied in both soils and tree rings of the marula tree (Sclerocarya birrea) in the vicinity of the Tsumeb deposit (Namibia). Amounts of all the studied metals and As are higher in the immediate vicinity of the Tsumeb Cu-Pb smelter in the soil. The tree rings also have their maximum content of all the studied substances in the vicinity of the smelter (with the exception of Pb). At a more distant site, the maximum concentration of Pb in the soils was 29.8 mg/kg, while the content in the soil in the vicinity of the smelter was as much as 8,174 mg/kg. In the vicinity of the smelter, the maximum Pb content in the tree rings reaches a value of 5.7 mg/kg, compared to a more distant site, where the contents are as high as 9.2 mg/kg. The lower Pb content in the trees on contaminated soil indicates that the composition of the xylem determines the above-ground uptake, rather than the root uptake. Similarly, the above-ground uptake is documented by the isotopic composition of Pb at the distant location, where the tree rings have different contents of Pb isotopes compared to in the soil. The As, Cd, Cu,

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				Pb, and Zn contents are highest in the tree rings from the 1950s (and older), along with those from the 1990s, while the Mn contents were highest in those from the 1960s and 1990s. The contaminant peaks in the 1950s and 1960s could be associated with the roasting of sulfidic ores, while the peak values in the 1990s could have been caused by the start of Cu slag reprocessing in the late 1980s, and culmination of works at the smelter prior to the closing of the mine. The tree rings of the marula tree were found to be a suitable archive for above-ground pollution close to Cu and Pb smelters.

F. Blood testing in National Health Surveys

National Health Survey	Non-Communicable Diseases Risk-Factors Surveillance	Source
Purpose	To provide up-to-date information on fertility and childhood mortality levels; fertility preferences; awareness, approval and use of family planning methods; maternal and child health; and knowledge and attitudes towards HIV/AIDS and other STIs.	Namibia, Demographic and Health Survey, 2013
Sample size	All men aged 15-64 years old, all women aged 15-64 years old, and all children under age 5 years old.	
Blood sample testing	Testing to determine HIV/AIDS, anemia, and blood glucose testing.	
Latest round	2013	
Next round	-	